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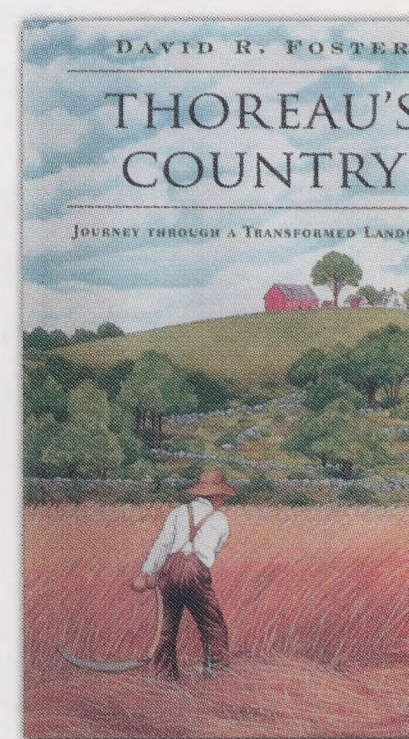
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JUST FOR KIDS

As a fairly new grandfather, I've become much more attuned to what young kids most enjoy when they visit the Zoo. And I'm pleased to see how much we offer kids.

First, kids like baby animals of all kinds, and new babies arrive here all the time. Two young bison, for instance, graze in our new American Prairie Exhibit, while three Sumatran tiger cubs will debut at Great Cats in late September. Great Cats, which opened a year ago, features Tiger Tracks, an interactive exploration area where kids can compare their lives to those of tiger cubs, and Kids Stop, where kids can get great views into the lion and tiger habitats and play on the soft flooring (while parents and grandparents can

rest thankfully in the shade). Back across from the American Prairie, adjacent to the Zoo Store, kids can crawl around the world on the huge map outlined on another soft floor.

Kids also like any animals that are smaller than they are. To a very young child, an elephant is so big as to become invisible, while a small mouse scurrying underfoot is fascinating. For this reason, prairie dogs have always been favorites. Now, kids can marvel at prairie dogs in two places at the Zoo: near Monkey Island and at the American Prairie Exhibit.

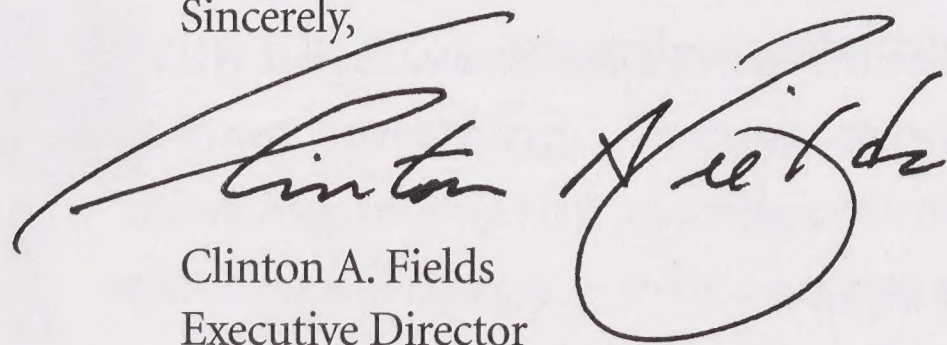
Kids can get a close-up view of many other pint-size creatures in the Small Mammal House and in the Invertebrate Exhibit. The Invertebrate Exhibit also features a new Touch Tank, where kids can touch and hold sea urchins, brittle stars, and other marine animals.

Just opened in August, a rabbit exhibit highlights animal domestication and features rabbits of a variety of domestic breeds including Flemish giants and giant chinchillas. Here, kids can learn about how these small giants came to be.

All the fun animals aside, kids like to play at grown-up activities. For several years, one of the most popular kids' activities at our Seal Days has been "Be a Keeper," in which kids don high boots and overalls and find out what it's like to take care of animals. Now, we've remodeled the old ZooLab in the Visitor Center to create "How Do You Zoo?" In this interactive, role-play exhibit, complete with a plush animal zoo habitat, a hospital examination room, a food preparation area, and a keeper office, kids can try their hands at being a keeper, a veterinarian, or a commissary worker. "How Do You Zoo?" will be open to families on weekends and to school groups on weekdays.

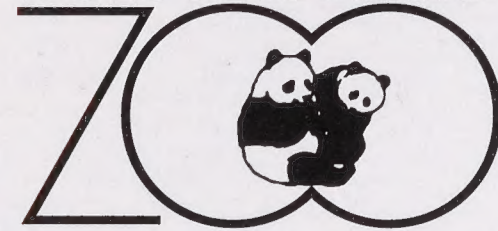
To celebrate all that's new at the Zoo, we will be hosting a members' open house on November 20. In addition to seeing the new exhibits mentioned above, you can also visit the Grevy's zebras, now back in their renovated habitat at the Cheetah Conservation Station, as well as the American alligator in a new enclosure outside the Reptile Discovery Center. Volunteers and keepers will be on hand to answer questions and refreshments will be served. Please plan to join us for a great morning at the Zoo.

Sincerely,


Clinton A. Fields
Executive Director

P.S. Apart from all there is for kids every day at the Zoo, FONZ offers a full array of special activities from camps and classes to events like Guppy Gala and the Kids' Creation Station at the Wildlife Art Festival. New this year will be our first-ever "Boo at the Zoo," an evening of Halloween trick-or-treating in the wildest neighborhood in town. Look for details about this new event in your next *Wildlife Adventures* newsletter.

Friends of the National



is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the Smithsonian National Zoological Park as one of

the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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The Smithsonian National Zoological Park is located at 3001 Connecticut Ave., N.W., Washington, DC 20008-2537. Weather permitting, the Zoo is open every day except December 25. Hours: From May 1 to September 15, grounds are open from 6 a.m. to 8 p.m.; buildings, 10 a.m. to 6 p.m. From September 16 to April 30, grounds are open from 6 a.m. to 6 p.m.; buildings, 10 a.m. to 4:30 p.m. **Director:** Michael H. Robinson.

Membership in FONZ offers many benefits: publications, discounts on shopping, programs, and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, DC 20008, or call 202.673.4961.

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
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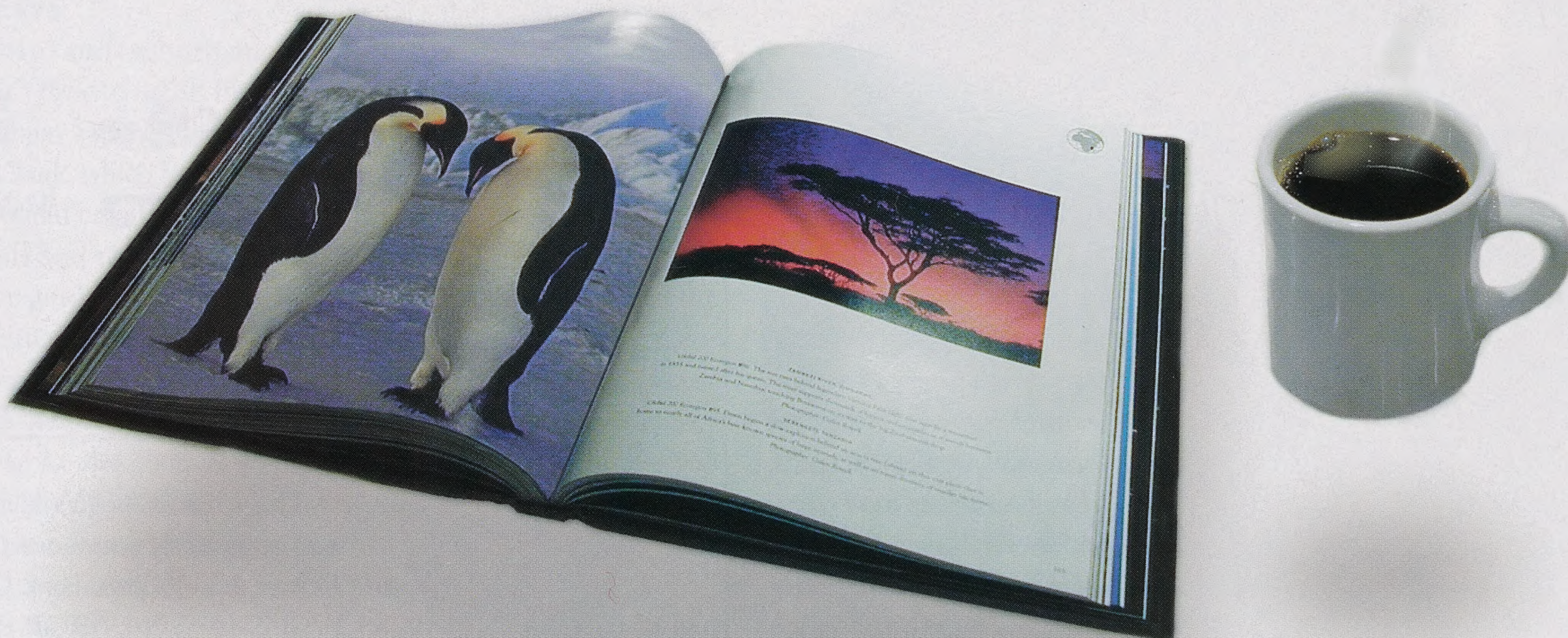
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Cover: The Zoo's Bactrian camels (*Camelus bactrianus*) by Jessie Cohen/NZP.

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World Wildlife Fund is proud to announce the publication of *Living Planet: Preserving Edens of the Earth*. This powerful book is a visual journey highlighting the 237 terrestrial, freshwater and marine ecoregions—known as the Global 200—that must be saved to preserve the Earth's web of life.

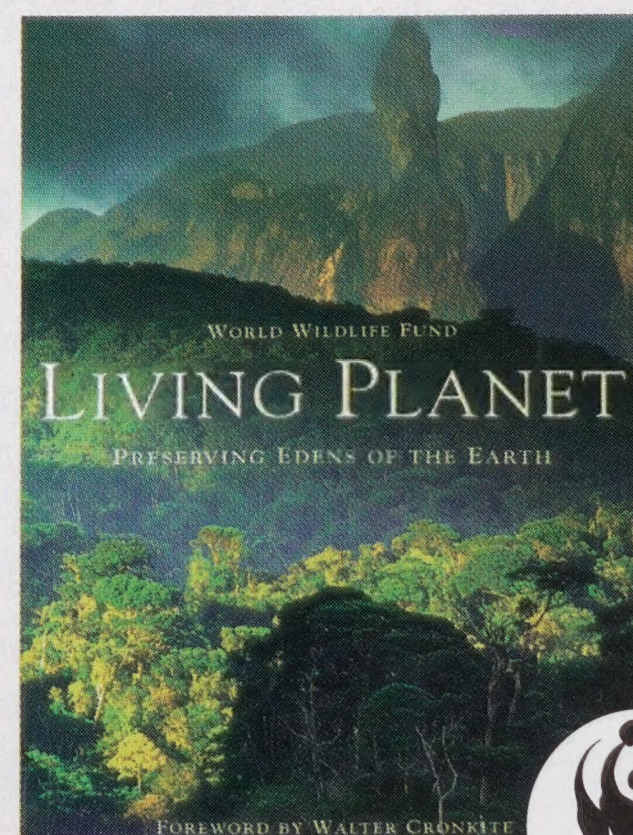
With a foreword by Walter Cronkite, and stunning full-color photographs by acclaimed nature photographers Frans Lanting, Galen Rowell, and David Doubilet, this 256-page book will inspire readers to share in World Wildlife Fund's determination to leave our children a living planet.

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A portion of the proceeds from *Living Planet* will help support WWF's efforts to preserve the wild spaces and species of the Global 200.



NOTES NEWS



JESSIE COHEN/NZP

FIESTA MUSICAL

In celebration of Hispanic Heritage Month, the Zoo will once again pulse with the music and dance of Latin America on Saturday and Sunday, September 25 and 26,

from 11 a.m. to 6 p.m. Fiesta Musical is a family event that features cultural dance performances, traditional crafts, a Latin American food court, and lively musical performances. Embassy staff from Mexico, Central, and South America will be present this year to share their countries' literature, costumes, and music. In addition, bilingual

animal demonstrations and hands-on activities will offer something for all ages. Admission to Fiesta Musical and the exhibits is free. Call 202.673.4717 for more information.

FONZ ANNUAL MEETING

Come one, come all! FONZ members are cordially invited to attend the FONZ Annual Meeting, to be held in the National Zoo's Visitor Center on Friday, October 15, from 7 p.m. to 9 p.m.

FONZ is involved in many crucial projects this year. From negotiations to bring a pair of giant pandas to the National Zoo, to the launch of a new capital campaign, FONZ's support for the Zoo is more important than ever. After an address by FONZ Board President Carole Valentine, National Zoo Associate Director of Biological Programs Benjamin B. Beck will provide attendees with a giant panda update, and FONZ Executive Director Clinton A. Fields will brief the crowd on the campaign to raise funds for a new education center and for other projects. The evening will conclude with hors d'oeuvres and an outdoor screening of panda-related features. Please note that there will be no Zoo-by-Night Tour this year. For a fun evening event, check out our new "Boo at the Zoo."

FONZ members interested in plans for the future of the organization are urged to attend this meeting to learn more. If you would like to reserve a place, please call 202.673.4637 or email annualmeeting@fonz.org.



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BOO AT THE ZOO

The Zoo will be transformed into a spooky neighborhood of ghosts and ghouls on October 29 and 30, from 5:30 to 8:30 p.m. Friends of the National Zoo will host the second annual Boo at the Zoo. Children under the age of 12, accompanied by an adult chaperone, may trick-or-treat from animal house to animal house within the Zoo, visiting the Elephant House, Small Mammal House, the Bat Cave, the Reptile Discovery Center, and Lion/Tiger

Hill. Haunted trails, complete with spooky music, will create a spine-tingling experience for all.

Admission is \$6 for FONZ members and \$12 for nonmembers (children under age two get in free). Coupons for \$9 can be purchased from participating sponsors. For further information, call 202.673.4962 or visit www.fonz.org/calendar.htm. The event will take place rain or shine.



JESSIE COHEN/NZP

A JACK-O'-LANTERN INTERESTS TWO ZOO PYGMY MARMOSETS.

ANIMAL NEWS

Attention urban and suburban ocean lovers. It's time to revisit the Invertebrate Exhibit and experience the new Touch Tank, which features a suite of intertidal creatures that haunt tidepools and rocky coastlines. Under the guidance of an interpreter or animal keeper, visitors can feel the spindly arms of a brittlestar, hold a prickly sea urchin in their palms, stroke the shell of a horseconch, or get up-close-and-personal with a horseshoe crab. There is no fixed schedule for hands-on time at the Touch Tank, but keepers will troll the Invertebrate Exhibit periodically,

collecting small groups to visit the tank in the behind-the-scenes service area.

In other animal news, Kerinci, one of the Zoo's Sumatran tigers, gave birth to three cubs on June 24. The cubs will be kept with their mother in an inside den until the end of September in order to maintain their privacy during this sensitive time in their development. For the first three months, the cubs will nurse on Kerinci's milk, slowly making the transition to a carnivorous diet some time in October.

Late June also ushered in two baby golden lion tamarins (GLTs) in the Small Mammal House, which are now off their mother's back and exploring furtively. Out in the open air, the free-ranging GLTs in Beaver Valley did not pass field training and so will not be released in the wilds of Brazil in the fall. Each year, the Zoo tries to condition



KERINCI'S NEW CUBS.

several GLTs for later release in the Brazilian rainforest through the Golden Lion Tamarin Conservation Project. Before they go, the GLTs have to pass a "field test" in which they roam freely in Beaver Valley, ideally losing some of their zoo naivete and becoming more bush-savvy.

Over the past two years, Transbrasil Airlines has generously supported the Golden Lion Tamarin Conservation Project by sending

Zoo researchers to and from Brazil to attend conferences and conduct field research. To date, there are nearly 900 tamarins living in the forests of Rio de Janeiro State, 279 of which were reintroduced through the Project. The GLT Project's success would not have been possible without the generous contributions of non-profit and corporate organizations, such as Transbrasil Airlines.

—Tim Stoddard



JESSIE COHEN/NZP

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Hunter and Dad earning their turns. Photo: David Wheelock © Patagonia, Inc. 1999 800.336.9090 • www.patagonia.com

Camels: Of Service

The Zoo's two Bactrian camels shed in the spring. Great shaggy mats of fur slowly slough off, hanging from the animals like globs of golden brown cotton candy. A thick woolly winter coat is a requirement for an animal that withstands winter temperatures in the Gobi desert as low as minus 40°F. So too is shedding that heavy coat—in the desert summer, temperatures soar above 100°F—

..... and replacing it with a
SUSAN LUMPKIN lighter one.

The urge to peel away those messy sheets of wool is almost irresistible, like the need to peel away chipped paint or sunburnt skin.



LEFT: ©JOHN SEIDENSTICKER RIGHT: ©FIONA SUNQUIST

and Survival



And, were we camel herders, we would. Aside from a multitude of other products and services camels provide, two-humped Bactrian camels yield 11 to 17 pounds of wool each year, and some dromedaries, their one-humped cousins, provide four to nine pounds. People weave the wool into cloth for tents, clothes, and blankets.

But wool is a minor blessing, a bonus from animals that for centuries have offered people many gifts, from food to fuel and transportation. For instance, camels provide milk. Lots of milk. After giving birth, females can produce more than a gallon of milk a day for nine to 18 months, and camel milk is a major component of the diets of camel herders. Among some Saharan nomads, camel milk, sometimes mixed with camel blood, is virtually the only source of nourishment. Camel milk is also turned into butter and cheese, and fermented to produce an alcoholic beverage. In India, camel milk is believed by some to have medicinal properties, and is prescribed for jaundice, tuberculosis, and asthma. For Westerners raised on cow milk, camel milk may take some getting used to. On a visit to Kenya, I found the *café au lait* camel vile, the cheese only slightly less so, and choked it down out of politeness to my hosts, but slowly, so as to avoid the offer of seconds.

Camel meat is prized too, although animals so valuable for so many other things are generally slaughtered only when they can no longer work, or on special ceremonial occasions. Or, as happened in Mongolia in 1994, when herders killed camels rather than smaller beasts to meet government meat quotas; to stem the loss of camels, the government had to ban camel killing. Camels' thick hides are also a resource: They are fashioned into saddles and leather containers. Finally, dried camel dung provides fuel for fires, a significant resource in arid lands where wood is scarce.

Apart from food and fuel, the

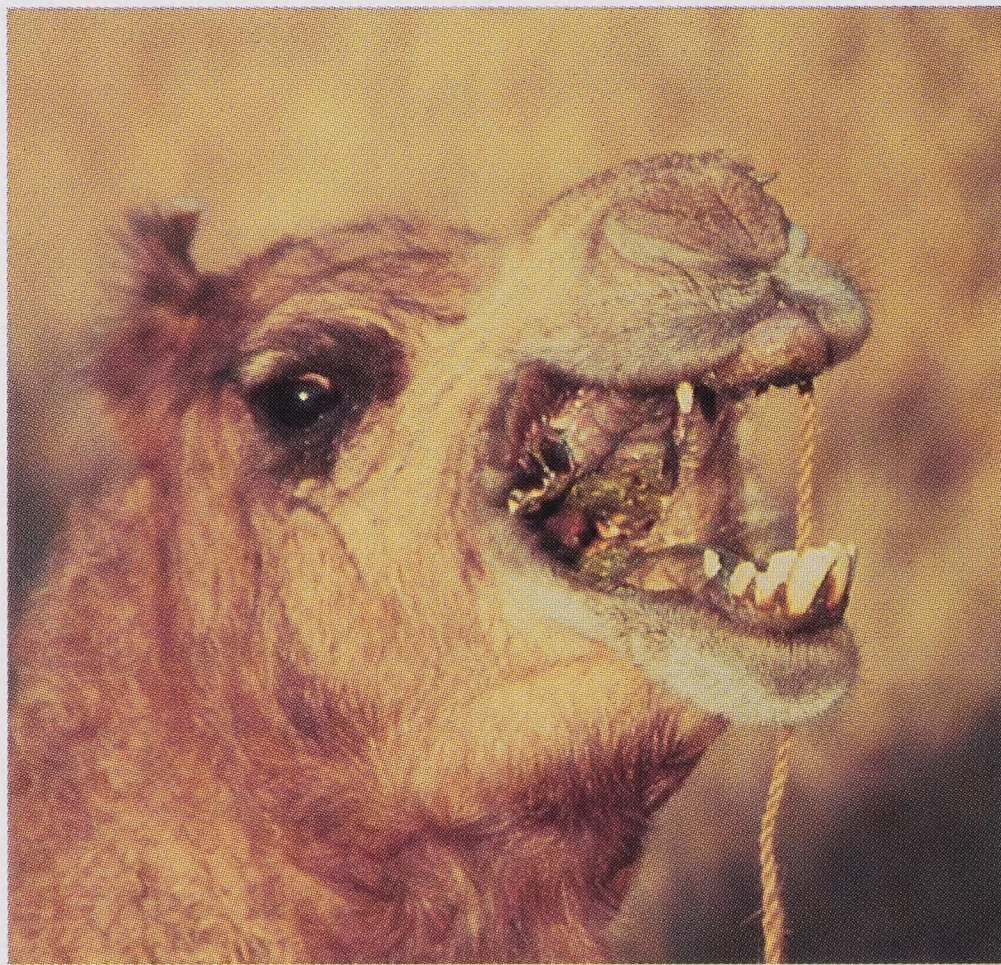
camel's other great utility is as a beast of burden. A camel can walk 25 to 30 miles a day, day after day, while carrying 300 pounds of cargo. Some breeds can carry more than twice this amount. And they can do this even in the searing heat or numbing cold of the desert. For centuries, camels were the vehicles of choice for traversing arid areas from western Africa to Mongolia and China. Great camel caravans plied the Silk Route from China through Central Asia to what is now Iraq. The earliest incense and spice trade was conducted using camels

Starting in the year 300, people from Morocco to Afghanistan began to give up their wheeled vehicles—chariots and carts.

to carry goods between the markets of Arabia and the Mediterranean. Just a few hundreds of years ago, caravans of as many as 120,000 camels—in straggling lines up to six miles long—linked Middle Eastern cities from Arabia to Jerusalem. Even today, camels move as much as 30 percent of the cargo traffic in the Gobi. In North Africa, it is still often cheaper to move goods by camel than by truck, although camel caravans are disappearing. Remaining, however, are 3,000-camel caravans that twice a year carry salt 375 miles from mines in Taoudenni, Mali, to Timbuktu, which lies in the center of that northwest African country.

Camels figure in a startling case of cultural reversal. The use of wheels is widely considered an emblem of cultural progress. But starting in the year 300, people from Morocco to Afghanistan began to

TO COURT FEMALES, MALES DROOL, SPIT, AND URINATE.



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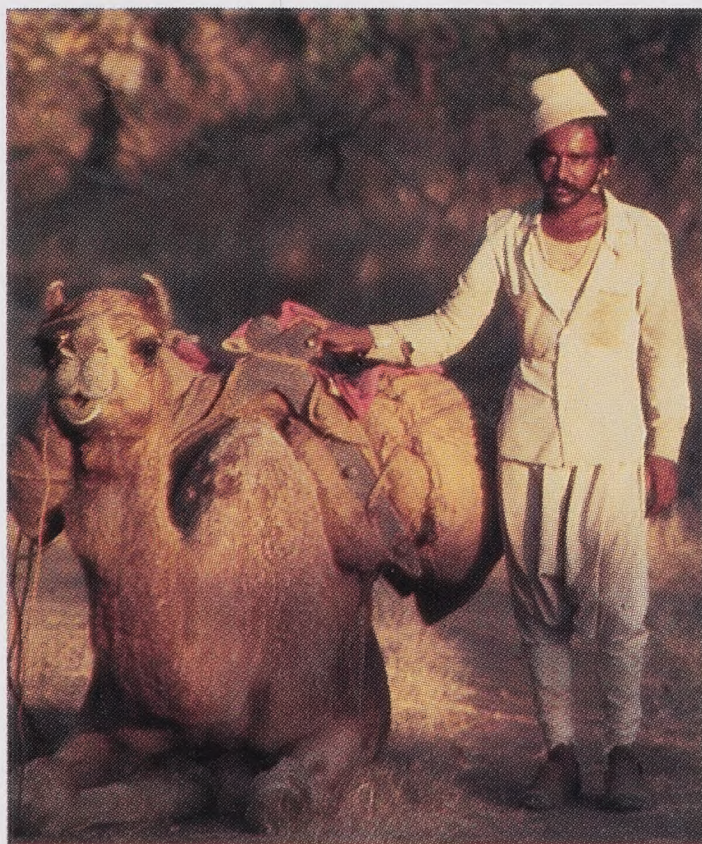
give up their wheeled vehicles—chariots and carts pulled by horses and oxen—in favor of more efficient pack camels; by the year 600, wheeled vehicles had been entirely abandoned. Only in the last century did wheeled transport vehicles begin to reappear. In other areas, however, camels were and are used mainly to pull wheeled carts and ploughs; this, in fact, was probably the first and primary reason for the domestication of the Bactrian camel.

With the proper saddle, a camel can also be ridden like a horse (as opposed to carrying people as if they were luggage). Soldiers as well as bandits mounted on riding camels loomed large in Saharan desert hostilities for about 2,000 years, declining only after World War I. Arabs conquered the Sahara on camelback, and, much later, in the

early part of this century, French camel corps "pacified" the Saharan nomads who resisted French colonial rule.

Bactrians appear not to have been used in battle. Genghis Khan conquered his huge Mongol empire on charging steeds, while camels plodded along carrying the provisions. In Mongolia today, horses are still far more prestigious than camels (caring for horses is men's work while women look after other livestock) and are as culturally important as camels are in the Sahara. Outside of the desert, to which camels are better adapted, horses are superior for riding into combat.

I have some experience with both animals, having ridden a horse and ridden a camel each once, in Montana and Kenya, respectively. On the horse, I felt like an extension of it, sitting solidly on its back and moving to its rhythms. On the camel, the sensation was of floating above it, like taking a ride in a ground-skimming balloon. One sits taller on a camel than on a horse, and sees farther. But I think I'd rather go into battle on horseback, and reserve camel riding for sightseeing.



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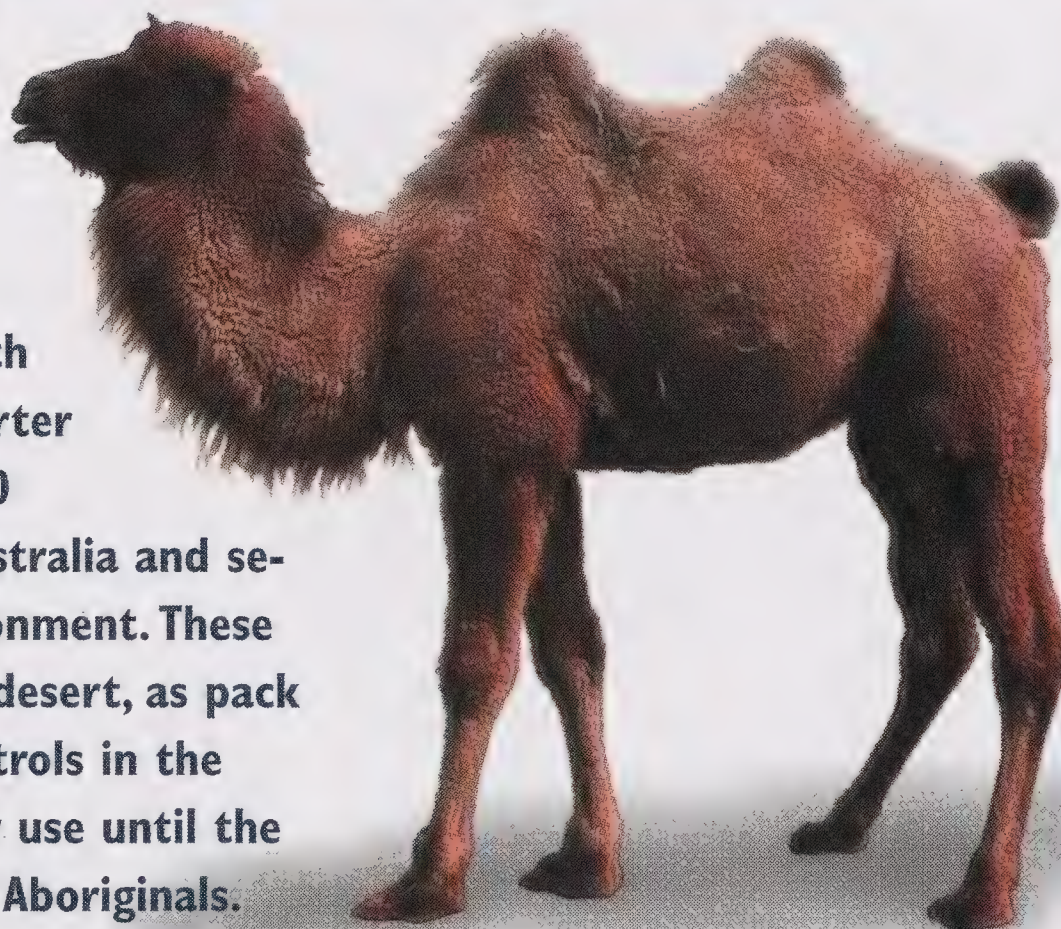
CAMELS IN THE COLONIES

The camel family actually originated in North America 40 to 45 million years ago and only moved into South America and Asia two to three million years ago. Then, about 10,000 years ago, camels died out in North America, although they did enjoy a recent, albeit brief, comeback on the continent.

A little-known bit of American history is that the U.S. Army imported about 120 dromedary camels into Texas between 1856 and 1858. They were used as pack animals, in battles with Native Americans along the Mexican border, and to survey western travel routes. Never popular with soldiers, however, the camels were largely underemployed, and the Camel Corps was dissolved during the Civil War. The remaining animals were sold off or released to fend for themselves.

About the same time, some Bactrian camels were imported to work in British Columbia and Nevada mines, but their North American careers were also short-lived and they too were released. Some of these animals and their descendants survived on their own for years. Feral camels roamed Texas until 1891, the Thompson Flats of British Columbia until 1905, and Arizona until 1905 when the last camel was captured and sent to the Los Angeles Zoo, where she lived until 1934.

Australia was more successful with its imported camels. In the last quarter of the last century, 10,000 to 20,000 dromedaries were imported into Australia and selectively bred to fit their new environment. These camels were used for exploring the desert, as pack and draft animals, and for police patrols in the outback. Camels were still in regular use until the 1950s and a few are still worked by Aborigines. Feral camels are now abundant, however, numbering a few tens of thousands in Australia's vast arid areas. These animals trouble sheep and cattle ranchers, especially during droughts, when the camels trample watering systems for livestock; camels also wreak havoc on fences.



CAMELUS BACTRIANUS.

4,000 to 5,000 years ago in southern Arabia, where coastal residents seemed to have subsisted largely on sea cows and a smattering of wild camels. Some authorities speculate that it was shared dependence on a limited number of watering sites in the desert that brought wild dromedary camels and people together. Jonathan Kingdon, noted zoologist and author of *Mammals of Arabia*, believes that these Arabs domesticated camels in a conscious act of conservation. At the time of domestication, camels, once existing in numerous species across a broad swath of arid Eurasia, were reduced to two species and the dromedary was in rapid decline. The dromedary's demise may have been due to overhunting, or to climate changes at the end of the last ice age that left its range increasingly hot and dry. By about 7,000 years ago, wild dromedaries were found only in southern Arabia and they became extinct there 2,000 to 3,000 years ago. Had those early Arabs not saved the camels—switched from consuming the meat of hunted camels to drinking the milk of live ones—these extraordinarily useful animals, animals that became a focal point of Arab culture and enabled Arabs to conquer the desert, would have been lost.

From southern Arabia, people slowly distributed dromedaries across the Middle East and North Africa, and during Roman times these camels reached as far as parts of southwestern Europe. In fact, a small number of camels worked in Italy until World War II.

Bactrian camels were domesticated in northern Iran and Turkmenistan about the same time as the dromedaries but these were almost certainly independent events. (Coincidentally, the camels' South American relatives—llama and alpaca—were domesticated at about the same time.) At that time wild Bactrians ranged from Turkey to Mongolia and the domesticate of this cold-adapted animal was adopted throughout this area. About 2,000 years ago, however, a cold-adapted dromedary was developed and came to dominate most of the domestic Bactrian's former range. Today, most of the world's 14 to 17 million domestic camels are dromedaries, and most of these live in Africa. Bactrians—about 2.5 million—are found in Central Asia, where they form just a few percent of the total livestock population. Our knowledge about the two species mirrors the sizes of their populations. Most detailed scientific information about camels pertains to dromedaries.

—S.L.

Deserts and Domesticity

In return for all this service from camels, people give camels water when they need it. Despite an impressive array of adaptations for life in the desert, domestic camels do rely on people to provide them with water. But few camels are fed by people (although quite recently wealthier camel owners began to feed their camels). Rather, camels forage more or less freely, getting all of their nourishment from plants, including many salty, dry, or spiny species few other animals will eat.

Under desert conditions, as in the Sahara where there is almost no surface water, camels are dependent on their owners for water, which

must be drawn from desert wells. Camels also become attached to a home area, to which they generally return, even from very far away. For this reason, many dromedary camels live in a semi-wild condition, their owners secure in the knowledge that, left to find their own food, camels will still regularly return to familiar wells to have water drawn for them. Even while working, camels generally forage freely, snatching what bites they can while walking slowly and then foraging farther afield during breaks and at night. Guarded camels—those not allowed to roam unattended by herders—also largely fend for themselves to find food.

Dromedaries were probably first domesticated



JESSIE COHEN/NZP

Unlike dromedaries, Bactrian camels still exist in a wild state, but in very low numbers. Once widely distributed through the Gobi and into China, camel numbers have been declining for 50 years due to competition for food and water with livestock, new roads cut through their once-isolated domain, and hunting. Today, perhaps 1,500 survive (although estimates range from a few hundred to several thousand), most in Mongolia's 17,000-square-mile Great Gobi Strictly Protected Area, which was established for their conservation in 1976. Wild camels also hang on in China, particularly in a desolate area around a dried-up lake called Lop Nur, near a former nuclear-testing site. The remoteness and hostility of the habitats has kept most people out of these sanctuaries. Still, the camels remain threatened by hunters, and by herders and miners moving inexorably into the desert, where they occupy the oases and thus deny access to water to the profoundly shy wild camels.

Wild Bactrians were unknown to Western scientists until 1877, when the Russian biologist-explorer Nikolai Przewalski, known also for "discovering" the wild horse called Przewalski's horse, or tahki (see *ZooGoer* September/October 1997), saw them in China. And whether this wild population was ancestral to the domestic form or consists merely of escaped domestics gone feral had been the subject of some debate until recent genetic analysis confirmed that the wild and domestic populations are distinct. The two differ in appearance. The wild form is smaller, slimmer, and narrower—its Mongolian name *havtagai* means flat—and has smaller, neatly conical humps compared to the big floppy humps of the domestic.

Saving Every Drop

Every schoolchild knows there are two kinds of camels: one-humped and two-humped. We call all one-humped camels dromedaries (from *Camelus dromedarius*), a word from the Greek for "rode" that was once applied only to camel breeds used for riding and racing. Two-humped camels are called Bactrians (*Camelus bactrianus*), a reference to an ancient country—Bactria in southwestern Asia—where these camels were once wrongly believed to have been domesticated. The two species do interbreed, and interbreeding may have contributed to the development of

cold-adapted dromedaries noted earlier.

No one knows when camels' humps first evolved, but one-humped varieties may have evolved from two-humped species in the hot, dry climates of Arabia. A single

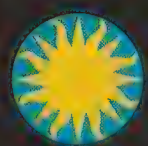
hump has a smaller surface area from which to absorb heat and lose water than a double one. Whether one or two, humps have the same function. Camels store fat (not water!) in their humps, which they burn during periods of food scarcity or during extended bouts of hard work when they are given little time to feed. The fat-filled hump may also slow the conduction of heat from the sun to the delicate internal organs.

It's not surprising that so many people be-

lieved humps stored water. Camels can go without drinking water longer than any other domestic animal. During the cool winter season in the Sahara, for instance, camels get all the water they need from the plants they eat and thus may go six or seven months without drinking. During the summer, camels need drinking water but even at the hottest daytime temperatures in the Sahara, which may exceed 118°F, camels drink only every five days. When temperatures range between 85°F and 95°F, drinking at 10- to 15-day intervals is typical. During each watering bout, however, camels quickly drink huge amounts of water—up to 50 gallons in a few hours—when they've gone five to seven days without. (The herders' job of watering camels is thus serious work; imagine drawing that amount of water from a well for dozens of camels.)

Camels can go so long without water because they lose it very slowly and can withstand high rates of dehydration that may result in the loss

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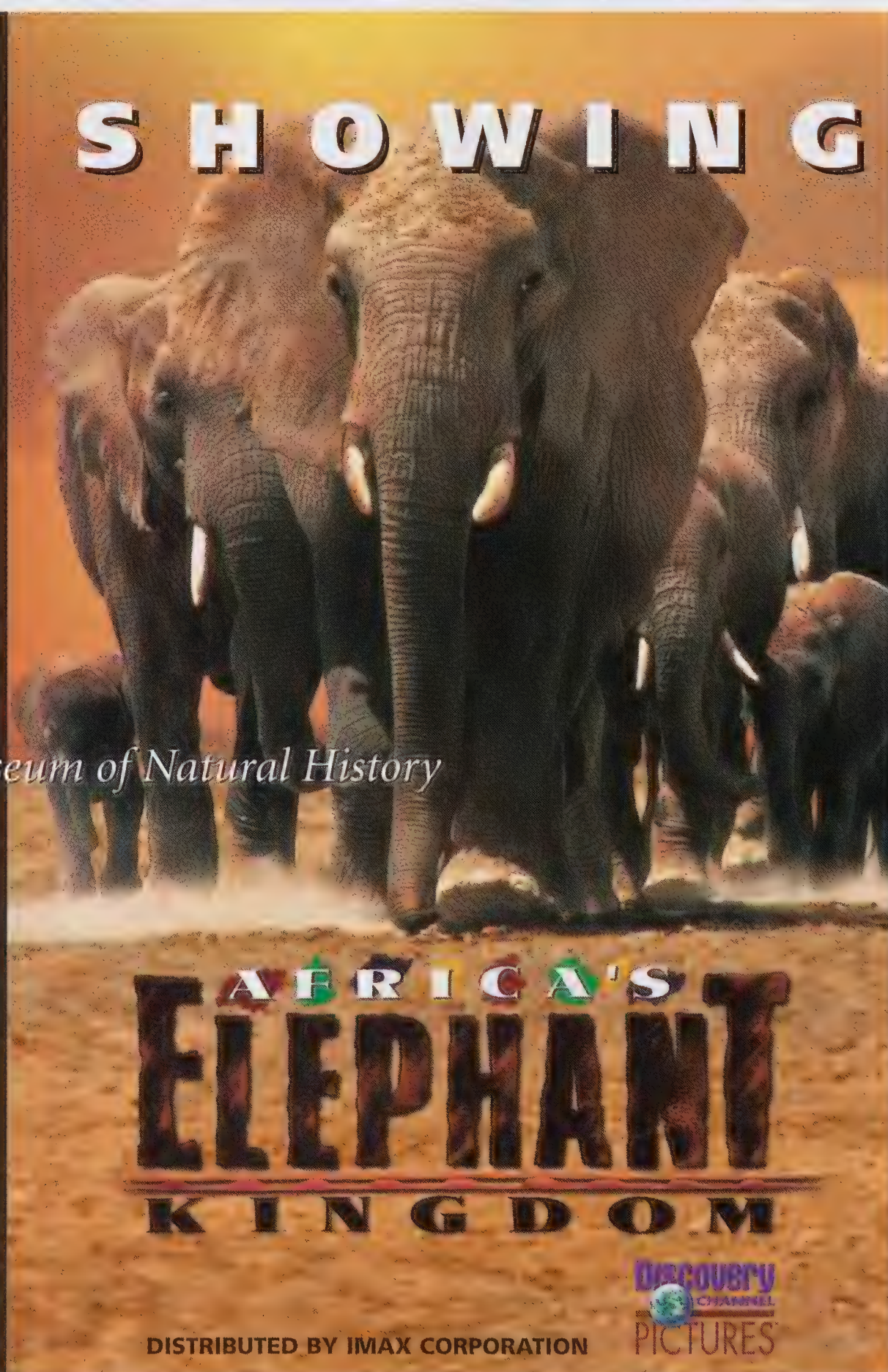


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LEE BOYD

IN MONGOLIA, HERDERS TEND DOMESTIC BACTRIANS ON THE STEPPES, WHILE WILD BACTRIANS ROAM IN THE GOBI DESERT.

in their book *The Camel*, Hilde Gauthier-Pilters and Anne Innis Dagg said, “The hard living conditions... forge a close bond between animals and men, probably closer

of more than 30 percent of their body weight. A 12-percent water loss leaves a person, for example, near death, while a 15-percent loss is lethal to most mammals.

Camels save water by producing dry feces and only small amounts of urine. More important, the camel’s body temperature rises with the daytime ambient temperature to as high as about 104°F. Matching the ambient temperature prevents sweating because the animals aren’t hot.

Body temperature then falls as its surroundings cool in the evening. Camels do have sweat glands; however, sweat evaporates under the fur, where it provides the maximum body cooling. (This is why camels are shorn only in milder, semi-arid areas such as northern Kenya—shorn camels lose far more water than those from which wool is collected as it sheds naturally.)

Camels also minimize water loss through behavior: They rest as much as possible or allowed during the day (camel caravans often traveled only at night during the summer), huddle in whatever shade is available, use each other for shade, and even sit or stand facing the sun, a posture that exposes as small a surface as possible to the burning rays.

It’s all the more shocking then to witness a male camel in rut. Like a miser who suddenly starts throwing dollars into the wind, a rutting male wastes water prodigiously. To court females and intimidate rivals, rutting males drool and spit and urinate like leaky fountains. They reek of an oily secretion that flows copiously from

scent glands on their napes. This seems to me to be a perfect example of Israeli biologist Amotz Zahavi’s “Handicap Principle” of sexual selection, developed to account for the evolution of male traits, such as a peacock’s long tail, that have no

than that in any other culture.” This bond is partly revealed in the vocabulary of Saharan nomads, which boasts about 700 different words for describing camels.

The forces of modernization, however, may soon spell an end to nomadism and camel-human mutualism. In Arabia, where domestic dromedary camels originated, a diminishing number of camels are now kept largely for pleasure and prestige. On the other hand, camels have become increas-

Modernization may soon spell an end to nomadism and camel-human mutualism.

survival value — may indeed be counter-productive to survival — but are attractive to females. Applied to camels, the Handicap Principle suggests that those dripping males are saying, “I’m so strong I can afford to waste water and still be fine, so mate with me and your sons and daughters will be equally strong.” The message to male rivals may be similar: “I’m really tough so don’t mess with me.”

Adaptations to conserve water and to survive on poor vegetation make it possible for camels to live in harsh desert environments, but not without human help at the well. In return, camels have made it possible for people also to live in such environments. The relationship between camels and people is truly mutualistic. In talking about the camel nomads of the western Sahara

ingly important in semi-arid areas, such as northern Kenya and Pakistan, where they are more efficient milk and meat producers than cattle and cause less environmental degradation.

In *Covenant with the Wild: Why Animals Chose Domestication*, Stephen Budiansky argues that “...in an evolutionary sense, domesticated animals chose us as much as we chose them.” He believes that animals became domesticated only because living with people and providing us services was essentially a better deal—resulting in greater reproductive and thus evolutionary success—than living wild. For camels, this argument carries some weight. With the ancestors of dromedaries extinct, and those of Bactrians on the verge, the domestic forms continue to thrive. Z



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RED-TAILED HAWK.



Wildlife in t

High in the Cascade Range, beyond the reach of sport utility vehicles, lies snowy, roadless wilderness that is one of the lynx's last strongholds south of Canada. Vulnerable to habitat disturbance and trapping, the reclusive, tuft-eared lynx has vanished from much of its range. These stresses aside, lynx are vulnerable to predators such as pumas and coyotes, and cannot compete with bobcats, their more adaptable cousins, which flourish in less snowy environs.

"The research isn't entirely clear, but we know that the only places where lynx persist in the Lower 48 are roadless," says Mitch Friedman, executive director of the Northwest Ecosystem Alliance, a group that battles to save wilderness areas. "The most likely reason for that is that roads give access to trappers, competitors, and predators. Also, if roads are being used by anything that eliminates snow—that melts it, plows it, or compacts it—they are a way coyotes, cougar, and bobcat can have greater access to the high country."

Cars themselves can become de facto predators. In the late 1980s, an effort to re-introduce lynx into New York's Adirondacks failed after cars traversing the road-riddled area killed many of the released animals. "A closed road is certainly better than an open road," says Friedman. "But the absence of a road is better than a closed road."

The shotgun marriage between roads and adjacent wildlife habitats is often a complex, vexing relationship, especially when it comes to wide-ranging creatures such as lynx, bears, and wolves. As cities large and small grow, roads inevitably spill across the land, cutting through wildlife habitat along the way.

It is hard to imagine life without roads. Arteries of human life, they move our com-

mercial and personal goods, get us to work, return us home, and get us away from it all. Ever since Native Americans followed bison and deer trails across prairies and

through woods, followed by the European settlers and their horses and wagons, North Americans have favored taking the road more-often traveled. As we trundle over roads, we often overlook their great ecological impact. A quick peek at some road statistics hints at their heavy footprints on the land. For instance, road corridors—the area including roads and their maintained margins—cover about one percent of the United States, or an area about the size of South Carolina, according to a 1998 study published in the *Annual Review of Ecology and Systematics* by Richard T. T. Forman and Lauren E. Alexander. However, the authors stress that roads' ecological impacts extend further, affecting 15 to 20 percent of the United States. All together, the country's public roads span 3.87 million miles. About ten percent of these crisscross national forests for a total of 380,000 miles—enough to circle the earth 15 times.

Sudden Impact

As any driver who looks beyond the steering wheel knows, roads aren't bad for all wildlife. Keep your eyes open along the margins of Interstate 95 in Maryland and Virginia and you will see red-tailed hawks, groundhogs, and



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WHITE-TAILED DEER.

BY HOWARD YOUTH



BIGHORN SHEEP

“What we see at the roadside is not nature,
but a face we have painted for nature.”

—Richard Manning, author of
*Grasslands: The History, Biology, Politics, and
Promise of the American Prairie.*

The Fast Lane



GROB & ANNE SIMPSON

NORTH AMERICAN LYNX.

NORTH AMERICAN BLACK BEAR.



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bluebird boxes that shelter their namesake birds and other cavity-nesting species. In California and Texas, a raptor called the white-tailed kite has greatly increased its range thanks in part to highway median strips, where it finds a variety of small rodents. Coyotes, notorious rodent catchers, are also common along western roadsides, while unmowed highway margins, and those seeded with native wildflowers, attract an array of butterflies. Around the world, from Australia's busy urban highways to dusty roads cut through the Amazon, a cadre of animals adapted to disturbed habitats flourishes. In remote areas, large cats such as tigers and pumas often use roads for easy travel and to track prey along the forest edge. That is, until a truck or car rolls near.

Roads lead to most of the world's most important wildlife sanctuaries, the wild playgrounds where we commune with nature. Most of the millions of Americans fueling the \$60-billion-a-year wildlife-watching industry view bears, elk, butterflies, flowers, or birds from their cars or from roadside overlooks or trails leading from park roads. Many wildlife biologists do their census work from roads, and the U.S. Geological Survey's nationwide Breeding Bird Survey is conducted by thousands of volunteers who listen and watch birds along set roadside routes.

While roads open the door for naturalists to study nature, smooth pavement and hurtling vehicles often bring drivers and wildlife too close for comfort. In the United States, an estimated one million vertebrates—amphibians, reptiles, birds, and mammals—are run over each day. Many animals are drawn to roads by carrion (usually previous roadkills), road salt, or insects. Others are just trying to cross the road. "Sometime during the last three decades, roads with vehicles probably overtook hunting as the leading direct human cause of vertebrate mortality on land," wrote Forman and Alexander. Roads and their attendant vehicles have harmed populations of rare species such as South Texas' ocelots, Florida panthers, Florida black bears, and also those of slow-growing animals such as box turtles. Amphibians, many of which cross roads



TRAFFIC NOISE MAY AFFECT BIRD BEHAVIOR.

©ROBERT RATTNER

to reach breeding sites such as vernal pools, often decline where cars prevail.

However, road mortality does not seem to dramatically affect populations of adaptable, fast-breeding animals such as opossums, raccoons,

small mammals, turtles, and amphibians often go out of their way to avoid crossing roads, as do a variety of large mammals including grizzly bears and wolves. One study in Germany showed reduced genetic variability in common frog populations following isolation by roads. Roads as narrow as seven-and-a-half feet wide prohibited carabid beetles and wolf spiders from crossing. Another study, which appeared in the *Journal of Mammalogy* in 1984, found that "movements of prairie voles and, to a lesser degree, cotton rats were restricted by something as seemingly innocuous as a narrow, seldomly used vehicle path" that was less than nine feet wide.

Roads can, and often do, change adjacent wetlands' hydrology by blocking groundwater flow and carrying chemicals and sediment to the water. In addition, car tires often transfer weed seeds, many of them exotic species, from one place to another. In these ways, roads can spur changes in plant composition, water level, or water clarity, which in turn can affect declining animal populations.

Just the sound of traffic is enough to affect birds. A Netherlands study revealed that 60 percent of bird species occurred in lower densities in grasslands and woods near highways than away from them. While pinpointing the reasons requires further study, possible causes of the decreased abundance include birds' sensitivity to noise and hampered communication due to road noise blotting out the birds' calls and songs.

Roadside lighting also confuses wildlife. For instance, young sea turtles emerging from beach nests at night may head for street lamps instead of moonlight and never find their way to the ocean. Street lights also disrupt amphibian breeding around wetlands, while light reflected off road surfaces tricks mayflies, important insect prey for fish and other aquatic predators, into laying their eggs on roads instead of in streams.

However, one of the most dangerous aspects of roads is that they carry people into wilderness.

Road Meat

One of Africa's most serious wildlife crises involves logging roads carved into Central Africa's

"Few environmental scientists, from population ecologists to stream or landscape ecologists, recognize the sleeping giant, road ecology."

—Richard T.T. Forman and Lauren E. Alexander
in the *Annual Review of Ecology and Systematics*, 1998.

gray squirrels, and white-tailed deer. For example, thousands of deer are hit on eastern U. S. highways each year, threatening both deer and drivers. But deer populations still flourish along grassy roadsides. This is true even in heavily developed areas like Montgomery County, Maryland, where Maryland Department of Natural Resources statistics reveal that hunters shot 2,624 deer in 1997, while cars and trucks took 1,902.

Build It and They Might Go

Roadkills aside, biologists find that roads affect some animals—and their habitats—in more serious ways. For one thing, while some animals flourish along the edge habitat created at roadsides, many do not. Also, many animals, both large and small, simply will not cross roads. The treeless earth, which is warmer and drier than surrounding woods or brush, the noise, and the confusion of busy roadways create formidable barriers that often cleave wildlife populations, potentially affecting their genetic variability by limiting breeding possibilities. Studies show that

moist tropical forests. As wood supplies in Southeast Asia and West African forests have diminished, large logging companies now set their sights on Central Africa's more remote and less disturbed tropical rainforests. In areas where logging begins, biologists are finding that large animals often vanish. While primates and other wildlife can sustain limited logging in their habitat, they are disappearing from these areas for another reason: heavy hunting. In countries such as the Republic of the Congo, timber companies bring in loggers who sustain themselves and their families on wild meat and moonlight as market hunters, selling "bush meat"—meat from elephants, gorillas, chimpanzees, duikers, and other forest animals—in city markets. The expanding logging-road network fuels a growing wild meat industry and conservationists, noting widespread declines in large animals, are demanding that timber companies and governments help halt the rampant hunting before it decimates populations of such well-known animals as western lowland gorillas, forest elephants, and chimpanzees.

"In general, people in Africa have always harvested wildlife, mostly for their own subsistence," says John Robinson, the vice president for international programs at the New York-based Wildlife Conservation Society. "The big issue from a conservation standpoint is the commercialization of that trade. As people moved into cities and retained a preference for wild meat, they have developed a broad market."

"The logging roads are dirt roads carved out so they can move big trucks with logs," says Robinson. "They're great roads. They're straight, flat, well-graded, and allow very rapid access back into the forest—and easy transportation for getting stuff out, be it wood or wildlife."

The dangerous combination of road-building and commercial wild meat hunting is not unique to Africa. "We're keying on Africa primarily because it's happening right now. It already happened in Asia, and it may happen in Latin America," says Robinson. While the African bush meat crisis has yet to be tackled by governments and logging companies, some lending institutions including the World Bank now define their ending policies to limit the exploitation of forest wildlife around forestry operations.

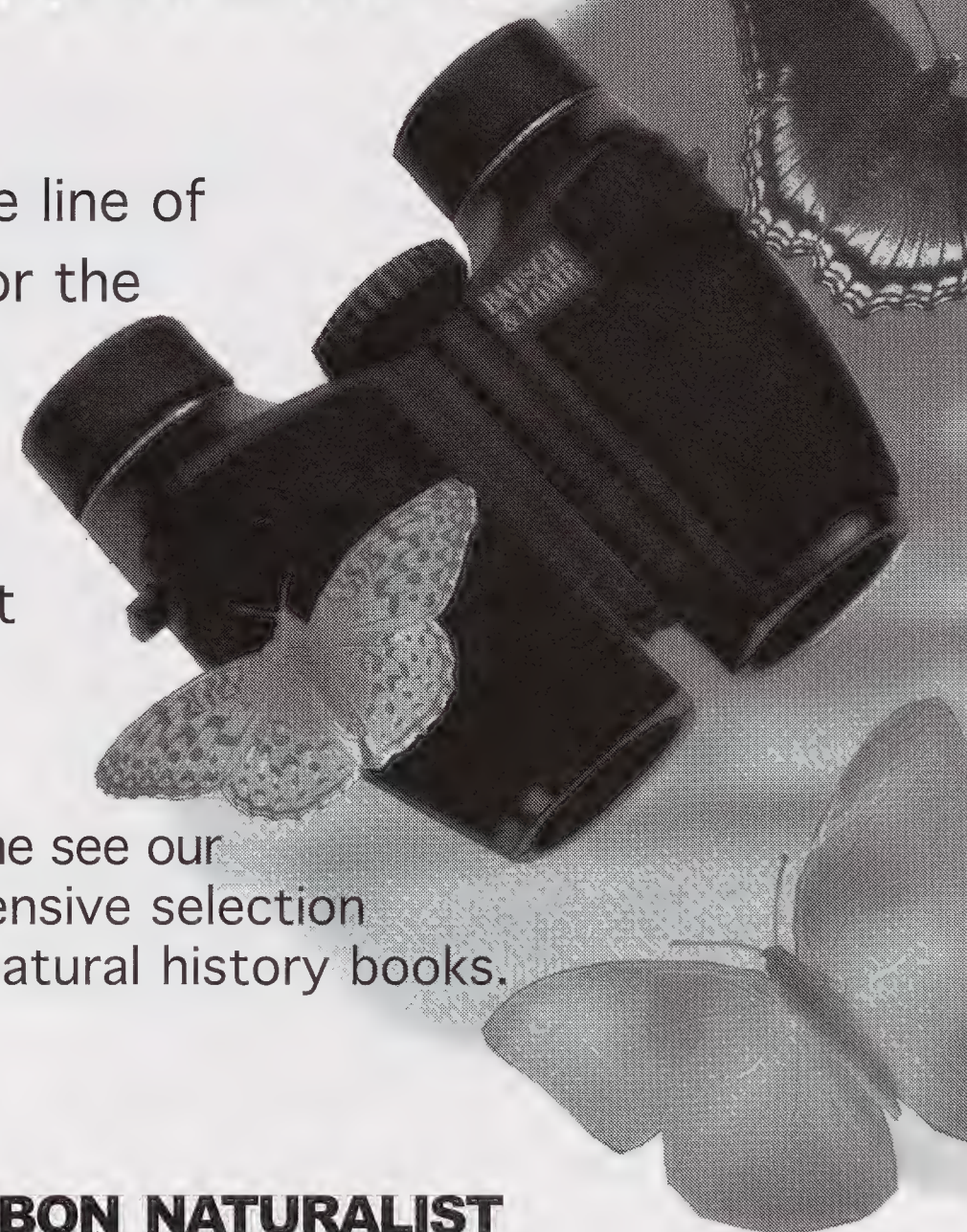
Of Wilderness and Wanderlust

Meanwhile, back in North America, conservationists and loggers are battling over the future of areas untouched by gravel, dirt, or asphalt. "Wilderness areas are by definition roadless, with roads built only to their edges. They are thus advertised as unique, as indeed they are," wrote essayist, conservationist, forester, and Wilderness Society co-founder Aldo Leopold in *Round River*, published in 1953. Leopold's writings and conservation work helped inspire the 1964 Wilderness Act, which now permanently protects about 104 million acres from road-building and other disturbances.

Conservationists estimate that about half of the United States' remaining roadless wilderness is currently protected under the Wilderness Act. The Wilderness Society and dozens of other environmental groups are urging the federal government to protect more acreage in the largest remaining undesignated roadless areas in national forests and on Bureau of Land Management lands. "Our hope is that the administration will permanently protect roadless areas because logging, road-building, and mineral developments unduly fragment critical wildlife habitat in the few remaining refuges there are in our national forest system," says Ken Rait,

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the director of the Heritage Forests Campaign, which represents 200 scientists, 460 conservation-related organizations, and more than 300 religious leaders. Rait and others believe that protecting roadless areas in national forests provides the best hope for saving lynx, grizzly bears, wolverines, and other large carnivores, as well as sensitive aquatic creatures like salmon, which decline when logging-road erosion sullies their spawning streams.

Research bears this out. For example, a University of Montana study found that more than 70 percent of western Montana's healthiest watersheds occur in wilderness areas. Studies of Minnesota and Wisconsin wolves, many of which live on national forest land, revealed that wolf breeding success depends upon low road densities (not exceeding 0.93 mile per square mile), not only because high road densities directly threaten wildlife, but also because they facilitate another menace — poaching.

For sheer wanderlust and vulnerability, the grizzly bear has conservationists most worried. Biologists and conservationists now believe grizzlies and other large carnivores cannot survive just in existing national parks. For example, in the Northern Rockies, where fewer than 1,000 grizzlies remain, the bears have home ranges up to 480 square miles—an area about one-third the size of Rhode Island—and their wanderings take them from national parks into surrounding national forests and private land. Many conservationists believe road-building and use should be restricted in grizzly country, and that larger reserves, including buffer zones around core areas like Yellowstone, Glacier, and Banff national parks, will be needed. The trouble is that roads, in addition to fragmenting bear habitats, inevitably bring people and the normally shy bears together. "The bears typically avoid traffic and roads," says Alliance for the Wild Rockies Executive Director Mike Bader, who recently published a study on bears and wilderness. "Very few bear deaths are collisions with automobiles. Most of them are management removals of habituated animals [that now eat human foods] and a lot of them are illegal killings or surprise encounters."

An 18-month moratorium on road building in many national forests (covering a total of 33 million acres) will expire late in 2000, when the U. S. Forest Service, which builds many miles of roads per year, will unveil a new policy regarding roadless-area protection. In the meantime,



WILDLIFE UNDERPASSES
WORK IN FLORIDA TOO.

CARS AND STRIFE: BANFF NATIONAL PARK

Each year, thousands of cars and trucks head east to west and west to east on the Trans-Canada Highway. Along the way, many speed over the Canadian Rockies, whirring through the flat wilderness expanse of the Bo River Valley in Canada's famous 2,600-square-mile Banff National Park. In this protected area, bumper meets wildlife far more often than conservationists would like—about half of reported wildlife deaths in the park are roadkills. In recent years, efforts to mitigate wildlife and vehicle conflicts have created their own dilemmas. For instance, bighorn sheep gravitated to the roadsides in cold months to lick de-icing salt off the pavement, often with fatal results. Now, with much of the highway fenced to keep the sheep and other wildlife from the roads, predators such as coyotes use the fences as corrals to trap and kill sheep near the highway.

Meanwhile, a series of 22 underpasses designed to allow wildlife access to the other side of the highway is used by elk and bighorn sheep, but doesn't seem to entice the park's wolves, grizzlies, and moose. Highway traffic and trains provide an even greater threat to these animals. For example, only one of the Bo River Valley's wolves survives; in 1991, 25 lived in the area in two packs. Since 1987, cars and trucks on the highway or trains barreling down nearby tracks caused 81 percent of known wolf deaths in the valley. While biologists and officials grapple with this situation, many fear that transportation through the park turns what should be a wildlife sanctuary into a wildlife cemetery.

Banff officials continue to experiment with exit gates animals can use if they wander from an unfenced area into the constrained, fenced part of the highway. Also, they recently built two wide overpasses that they hope grizzlies will use. Apparently permanent fixtures, the highway and railroad will continue to challenge park officials, who work closely with transportation officials, scientists, and concerned environmental groups to explore the best ways to help animals safely get to the other side of the road. "We're continually conducting research into reducing mortality," says Helen Kennedy, who works in the park's office of the superintendent. "It's active management that involves all stake-holders."

while some national forests are closing roads to protect water quality and wildlife, others plan to open new roads into sensitive areas, including some used by grizzly bears.

Even national parks have road headaches. Plagued by traffic jams that pollute park air and water and disturb wildlife, many parks are seeking ways to stem the flow of cars and RVs, while demands on the parks grow. In Alaska's Denali National Park, where visitors must park and take a bus into the park to minimize disturbance to wildlife, there are moves to build a new access road into the heart of the park. Other planned roads threaten parks in the U. S. West, while ex-

isting highways and paved park roads from the Everglades to Yellowstone to Alberta's Banff National Park create dangerous obstacles for protected wildlife.

A Rough Road Ahead

Road ecology is coming of age, and not a moment too soon. More than ever before, the complex issues involving wildlife and roads are beginning to draw conservationists and road planners together to find a middle ground that allows the best coexistence between animals and motorists. Roads will remain a very important part of our lives. But how, where, and whether

to build new roads through wildlife habitat, and how to retrofit current roads to minimize ecological damage, have become important environmental concerns in many areas. Not long ago, road-builders and planners rarely considered local ecology or asking biologists for guidance. Today, thanks to more stringent environmental laws and greater public concern over wildlife issues, planners in North America, Europe, and other areas are more likely to consider the natural contours of the land and avoid areas, such as wetlands and valley bottoms, frequented by wildlife. Wildlife managers and planners are beginning to work more closely to set speed limits, road densities, and road sizes through wildlife-rich areas, and to plan bridges that cause minimal disturbance to wetlands and water quality.

Permeability — a road's ability to accommodate wildlife movement with minimal fatality — is one of the greatest challenges when roads run through wild areas. Perhaps no other state has worked as hard to get a handle on this problem as Florida, the country's fourth most populous state and one of its most biologically diverse. Increased traffic and road-building threaten many of the state's animals, including the Florida black bear. Like the endangered Florida panther, this wide-ranging omnivore, which the state lists as threatened, has suffered from habitat loss and fragmentation and from roadkills.

Last year, a record 88 black bears died on Florida roads, and the population now may be as low as 1,500 animals. (The state once hosted an estimated 12,000.) "While habitat loss is the bear's number-one threat to survival, roadkills are the single most direct cause of mortality," says Tom Uniack, a Defenders of Wildlife program associate. Uniack works on the Habitat for Bears Campaign, a joint effort by Defenders and the Florida chapter of the Sierra Club to protect habitat and prevent habitat fragmentation and roadkills in Florida's bear country.

This group works closely with the Florida Fish and Wildlife Conservation Commission (FWC) and Florida Department of Transportation (FDOT), two state agencies that work together to save the state's bears using a blend of modern technology and proactive planning. A few years ago, the FWC finished a study that pinpoints wildlife habitats vulnerable to fragmentation, and produced maps marking bear kill locations. It has also begun to study bear movements in Ocala National Forest, where two state roads cross bear habitat. The FDOT uses these resources and the FWC's counsel when deciding where to site bridges, road expansions, or re-alignments that might affect bears or other wildlife. These agencies pooled their resources to install about 30 underpass structures in central and southwest Florida. Some of these underpasses, which usher animals beneath the roadway, are designed to keep Florida black bears out of harm's way, while many others are meant to keep Florida panthers from stepping in front of cars. A variety of other animals also use the underpasses. Planners placed most underpasses where regular animal movement occurs or in problem areas where roadkills were reported. Fences are often an important part of the underpass strategy: They bar animals from crossing the road while funneling them toward the underpasses. For panthers, of which only 30 to 50 remain, such mitigation efforts have reduced roadkill loss from ten percent annually to two percent.

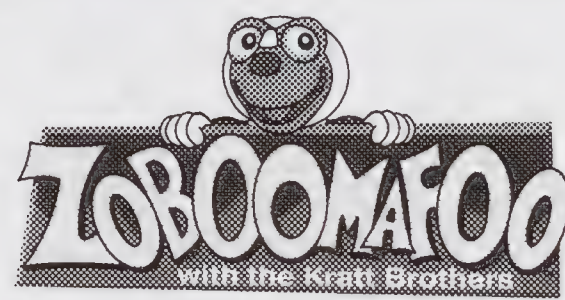
These days, imagining a future without roads is as difficult as picturing a world without wildlife. From reining in Africa's bush meat markets to protecting lynx and bears, conservationists, loggers, and road-planners will have much to discuss for years to come. And although the road may prove rocky, it's one we all must travel down together. Z

To view a map of roadless areas in the U.S., go to [www.fonz.org/zoogoer/zgl999/28\(5\)roads.htm](http://www.fonz.org/zoogoer/zgl999/28(5)roads.htm).

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† THE GREEN †

WHEN CHRISTOPHER COLUMBUS SAILED through the Caribbean 500 years ago, his crew reportedly had to push green turtles aside with poles to clear passage for the ships. Columbus saw so many green turtles around three low islands 150 miles south of Cuba that he named them "Las Tortugas," Spanish for "The Turtles." The name didn't last long — today these islands are known as the Caymans — and neither did the turtles. While the Caymans once hosted the largest green turtle rookery in the Americas, today the nesting wild turtles are all but gone from these tropical islands.

The story is much the same

BY ROBIN MEADOWS

throughout the green turtle's range, which once included tropical and subtropical waters worldwide.

RATTLE'S TALE



People's appetite for turtle products—from meat to eggs to jewelry made of their beautiful shells—has just about done in green turtles (*Chelonia mydas*) and the six other species of sea turtles that ply the world's oceans. But after years of decline, there is now hope for the green turtle in the Caribbean. For instance, green turtles are rebounding at Tortuguero Beach, a 22-mile stretch of black sand in Costa Rica that is the species' most productive nesting site in the Western Hemisphere.

Efforts to conserve green turtles in the New World date back to at least 1620, when the Bermuda Assembly passed an act to prohibit killing turtles less than 18 inches across within five leagues of the islands. The assembly decried the many fishermen who "snatch & catch up indifferentlye all kinds of Tortoyses both younge and old, little and greate and soe kill, car-rye away and devoure them to the much decay of the breed of so excellent a fishe."

The assembly's prediction that Bermuda was in "danger of an utter destroyinge and losse" of the green turtle has come true: Centuries of indiscriminate overharvesting has wiped out the islands' huge nesting population.

That turtles remain at all in the Caribbean is due largely to the efforts of one man—the late Archie Carr, a University of Florida zoologist who was hailed as "the greatest conservation biologist of these troubled times" in a tribute written after his death in 1987. Carr began studying sea turtles in the 1950s. By then, the last significant green turtle breeding site in the Caribbean was Tortuguero, Costa Rica's black sand beach. Carr was appalled to discover that nearly every female that came ashore to nest was captured before she could lay eggs, then shipped to market and sold for meat.

Fearing that green turtles would soon die out at Tortuguero Beach and ultimately become extinct in the Caribbean, Carr wrote about the green turtle's bleak outlook in *The Windward Road*, published in 1955. He proved to be as fine a writer as he was a biologist. A chapter of the book called "The Black Beach" won an O'Henry

Award for best short story.

More important, the book inspired New York newspaperman Joshua Powers to found The Brotherhood of the Green Turtle. In 1959, with funding from Tallahassee philanthropist John Phipps, the Brotherhood became the Caribbean Conservation Corporation (CCC), the first organization dedicated to preserving sea turtles.



THE HIGH DEMAND FOR SEA TURTLE PRODUCTS THREATENS ALL SIX SPECIES.

The CCC focused on protecting the nesting beach at Tortuguero and convincing the Costa Rican government to limit the harvest of adult green turtles.

That was a good start. But in the 1960s people knew so little about the turtles that they didn't know what else to do for them. Carr realized that the only way to save green turtles was to learn more about them. "To protect an animal, you have got to know where it is—not just once in a while but all the time," he noted in *The Windward Road*.

At that time, people knew that they nested only on particular beaches, and that the adults grazed on beds of sea grass and seaweed that grew along coastlines in tropical and subtropical waters around the world. What happened in between hatching and adulthood was anyone's guess.

In Carr's day, the four big questions about green turtles were: Do they migrate? Do they return to nest on the beach where they were born? How do they navigate? And, finally, where do the hatchlings go?

Carr himself confirmed, through an extensive tagging program, that green turtles do migrate. Since Carr began his work in the mid-1950s, more than 35,000 nesting females have been tagged. These studies showed that turtles that nest at Tortuguero Beach disperse to feeding grounds all over the Caribbean and beyond, migrating as far as Florida, Mexico, and Venezuela.

Studies inspired by Carr have also confirmed that green turtles return to nest on the beach where they were born, according to DNA studies by Brian Bowen of the University of Florida and former-Carr student Anne Meylan of the Florida Marine Research Institute in Melbourne Beach. Swimming up to 200 miles per day, both males and females return to mate in offshore waters. Females then crawl ashore, where they dig a hole and lay about 100 ping pong ball-sized eggs about two feet below the surface of the sand. Females lay up to six clutches over the course of the summer nesting season and then skip a few years before returning to the beach to nest again.

"Their tremendous migrations are some of the longest and most dramatic in the marine world," says David Owens of Texas A&M University in College Station, Texas. The green turtles that graze off the coast of Brazil embark on the most spectacular voyage of all. They swim about 1,200 miles through the open ocean to nest on Ascension Island, which lies roughly halfway between Brazil and Africa.

A mere seven miles across, Ascension Island offers a perfect example of the third sea turtle mystery: How do they find such a



SEA TURTLE RESTORATION PROJECT

TURTLE SHELL BRACELETS.

tiny piece of land at such a tremendous distance? Sea turtles can raise their heads only a few inches out of the water and have poor vision. Even if they could see well, few landmarks exist in the open ocean. "Animals that make scheduled convergences on small oceanic islands are doing some pretty far-out navigating," said Carr in his 1967 book *So Excellent a Fishe*.

Studies of hatchlings are now revealing how green turtles perform such feats of navigation. "Hatchlings seem to know exactly where they're going," says Blair Witherington of the Florida Marine Research Institute in Melbourne Beach. "They're in a frenzy—they pop out of their nests, run to the water, and swim like crazy."

The hatchlings need to be fast because the two-minute dash to the sea is short but perilous. Birds, crabs, and other predators snatch up and devour as many of the two-inch hatchlings as they can.

How do the baby turtles know which way to run? They emerge at night, when the cool air and sand make dehydration less likely, and find the sea by heading for the brightest horizon. Under natural conditions, the ocean is always brighter at night because water reflects more light than sand. When beaches have street lights or brightly lit buildings, however, hatchlings can get confused and run inland, where they dehydrate and die.

“To protect an animal, you have got to know where it is—not just once in a while but all the time.”

Once in the water, hatchlings swim continuously for about two days. They try to reach open ocean as soon as possible because sharks and other predators are abundant in nearshore waters. So many hatchlings are eaten on their way to the open ocean that fewer than one percent are estimated to survive to sexual maturity.

How do the hatchlings know which way to swim? At first, they swim into the waves, which parallel the beach when close to shore. Farther from shore, however, wave direction no longer correlates with the direction of shore. Biologists believe that hatchlings then switch to navigating using a biological magnetic compass. Studies by Ken Lohmann of the University of North Carolina at Chapel Hill show that sea turtles can indeed detect and orient according to magnetic fields.

Lohmann's work suggests that sea turtles can sense both the angle and intensity of the Earth's magnetic field, which vary depending on where you are on the surface of the planet. The angle of the magnetic field gives the latitude of a given position and the intensity gives the longitude. "Knowing where you are is essential to navigation," says Witherington. "The second thing you need to know is where to go. We think hatchlings somehow record the latitude and longitude of their natal beach."

Studies of hatchlings are also answering the fourth green turtle mystery: Where do the baby turtles go? Once again, Carr was basically right. "The most likely idea... seems to be that the hatchlings for a time become plankton, that they drift more or less passively in the open sea," he wrote in *So Excellent a Fishe*.

After swimming out to the open ocean, hatchlings get swept into convergence zones, areas where surface waters are driven into each other by currents or the wind. Convergence zones are also known as weedlines because they collect

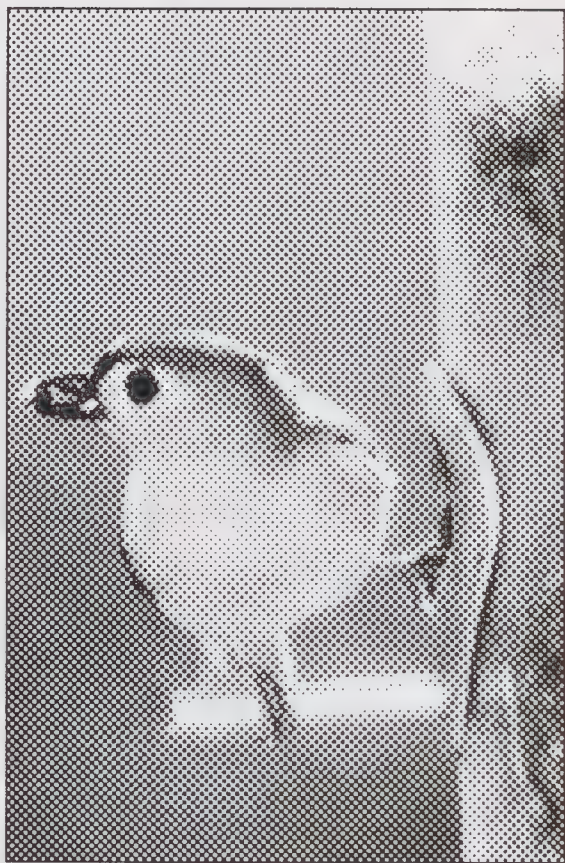
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GREEN TURTLES

sargassum, a brown floating seaweed. Weedlines range from being relatively small and ephemeral—narrow strips a few hundred feet long that last only while the wind blows—to being vast and essentially permanent. Where the Gulf Stream swirls up to the central north Atlantic, weedlines can be a dozen miles long and several miles wide, and so persistent that the area is called the Sargasso Sea.

For the few hatchlings that survive the gauntlet of the predator-filled beach and nearshore waters, weedlines are a haven. Few predators lurk in weedlines while prey abounds. Unlike adults, green turtle hatchlings are carnivorous and feed on all kinds of creatures from worms to crustaceans to insects. The baby turtles just float around and eat and grow until they reach eight to ten inches, which typically takes several years. Then they undergo a dramatic change, switching to a vegetarian diet of sea grass and algae and abandoning the weedlines for the adult grazing grounds.

Carr didn't muse about a fifth sea turtle mystery, presumably because he knew the answer. But generations of children have wondered why the mock turtle in *Alice in Wonderland* is always crying. It turns out that sea turtles

really do cry. They drink seawater and have to get rid of all that extra salt somehow. So they concentrate it in glands behind their eyes and shed large, salty tears.

While Carr's understanding of green turtles' basic biology was right, he would be happy to know that so far his prediction of the species' demise has been wrong. Far from dying out at their nesting beach in Costa Rica, the turtles are making a comeback. This is because Costa Rica has made green turtle protection a priority. The country has restricted the harvest of eggs and adults since the late 1950s and early 1960s, and recently banned the sale of green turtle eggs and meat altogether. In addition, in 1976 Costa Rica established Tortuguero National Park to protect the turtles' nesting beach.

Carr began keeping track of the number of nests built on Tortuguero Beach in 1971 and that work is being continued today by another of his former students, Karen Bjorndal, and other biologists at the Archie Carr Center for Sea Turtle Research in Gainesville, Florida. The surveys show

that the number of nests has tripled over the last quarter of a century, rising from about 15,000 in 1971 to 50,000 in 1996.

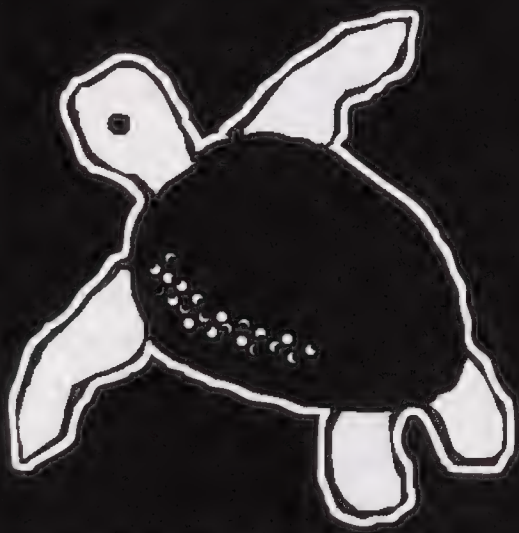
Promising as this is, the researchers caution that the increase in the number of nests tells us only that mature females are doing well. Hatchlings in the Sargasso Sea could be dwindling and we would not know it for decades because green turtles take 30 to 50 years to reach sexual maturity. "Drastic changes in the survival of early life stages...would not be apparent on the nesting beach for many years," wrote Bjorndal and her colleagues in the February 1999 issue of *Conservation Biology*.

On a smaller scale, green turtles are also rebounding in Florida, which holds 90 percent of the sea turtle nesting beaches in North America. In 1989 Congress established the Archie Carr National Wildlife Refuge on a 20-mile-long beach along Florida's Atlantic coast, between Melbourne and Wabasso. So far, the U.S. Fish & Wildlife Service (USFWS) has purchased nearly two-thirds of the remaining 9.3 miles of undeveloped beach in the refuge at a cost of \$60 million, which came from government conservation programs and the



FEWER THAN ONE PERCENT OF SEA TURTLE HATCHLINGS REACH MATURITY.

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GREEN TURTLES GET THEIR NAME FROM THE COLOR OF THEIR FAT.

Females then crawl ashore, where they dig a hole and lay about 100 ping pong ball-sized eggs about two feet below the surface of the sand.

Mellon Foundation. But without more funding, the USFWS may lose the chance to buy the rest of the beach because coastal Florida is being developed so rapidly. "Supporters of the Refuge are literally in a race against time to acquire the best remaining parcels of undeveloped land," says the Caribbean Conservation Corporation.

Since the refuge was established, the number of green turtle nests has risen from about 200 to nearly 2,000 in 1998. The refuge is also one of the world's most important nesting sites for loggerhead turtles, and the number of loggerhead nests there has increased from about 8,000 to about 22,000 in 1998.

While green turtles are doing well in the few sites where they are protected, they are declining in most of the rest of their range, says Marydele Donnelly, Washington, D. C.-based Program Officer of the IUCN Marine Turtle Specialist Group. The most serious threat worldwide is the harvest for meat and eggs. The biggest green turtle nesting population anywhere is in Australia, where island beaches just a couple of miles long can be crammed with tens of thousands of nests. But more than 100,000 green turtles are harvested each year for meat in the Australasian region. And eggs from nearly all the green turtle nests are harvested in Indonesia and Malaysia.

The best bet for protecting the green turtle is eliminating the markets for their meat, eggs, and shells, says Donnelly. Ways to do this include expanding international agreements to ban sea turtle trade, and encouraging people to rely on the turtles to attract ecotourism income rather than to provide food.

While ranching has been proposed for crocodiles and other types of wildlife harvested for their meat, this approach is simply not feasible for sea turtles, say both Donnelly and the Florida Marine Research Institute's Witherington. "Ranching is a bad idea because sea turtles are hard to raise due to their complicated life history—they're not like cattle," says Witherington. "Ranching could create markets for sea turtles, which could increase wild catchings. Wild sea

turtles will be less safe in a world hungry for turtle soup, eggs, and shell jewelry. I hope the world decides to want turtles swimming around more than turtle soup."

The second greatest threat to sea turtles is accidental deaths caused by fishing gear. Commercial shrimp trawling accounts for most of these fatalities. More than 55,000 sea turtles used to drown in shrimp trawling nets each year in waters off the southeastern U.S. alone. Since the early 1990s, shrimp nets in U.S. waters have been required to have Turtle Excluder Devices, which are like trapdoors that let turtles escape. But not all fishermen comply with this federal requirement, and these devices are not widely used elsewhere in the world.

Longline fisheries are a growing threat to sea turtles. Intended to catch bottom-dwelling fish, the 300-foot lines have six-inch hooks that also snag sea turtles. "There are billions of hooks on longlines in the open ocean and the fishery is growing rapidly—about 15 percent per year in the Indian Ocean," says the IUCN's Donnelly. She advocates closing longline fisheries seasonally in waters where sea turtles are abundant.

Another threat to sea turtles is marine pollution, particularly in the weedlines where hatchlings feed. In addition to collecting sargassum, baby turtles, and the creatures they eat, weedlines collect tar balls, plastic, and other debris. And, unfortunately, hatchlings appear to be indiscriminate eaters. "One of the scary things we find is that hatchlings have tar and plastic in their guts—about half have eaten tar and about a fifth have eaten plastic," says Witherington. "The number of sea turtles eating tar is high and alarming."

Tar can make their jaws stick together and both tar and plastic can plug up their digestive systems, which can ultimately kill the turtles. Analysis of tar yields a fingerprint of its component hydrocarbons, and Witherington has found that most of the tar in hatchling guts comes from bunker oil, which has not yet been refined. The most likely sources are oil tankers that flush sludge out of their tanks at sea instead of at reclamation facilities in port, he says. Because flushing at sea is already illegal, the answer is stronger enforcement. The same is true of plastics dumped at sea. "All this happens way out in the open ocean so sea turtles could be dying in great numbers and we'd never know it," says Witherington. "This is our first glimpse of what might be going on out there."

Marine pollution may also hurt sea turtles indirectly by weakening their immune systems, making them susceptible to disease and infection. For example, scientists are finding more and more green turtles with fibropapillomas, skin tumors that can reach ten inches in diameter. Turtles with fibropapillomas growing on or near their eyes, flippers, or mouths can have such a hard time seeing, swimming, or eating that they die. In some places, 80 percent of young green turtles are afflicted.

Fibropapillomas are a relatively new threat to green turtles. "You solve one suite of problems and turn around to another suite," says Donnelly.

"The good part of the story is that people are realizing that we have to conserve sea turtles by regional management. This is a breakthrough—it's not just what you do here in one place that counts with migratory species."

Archie Carr couldn't have said it better himself. Z



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BOOKS. NATURALLY

***Thoreau's Country:
Journey Through a Transformed
Landscape.***

1999. David R. Foster.
Harvard University Press,
Cambridge, Massachusetts.
270 pp. Hardcover, \$27.50.

Concluding a lecture at the Concord Lyceum in 1851, Henry David Thoreau is reported to have said: "...in wildness is the preservation of the world." In *Wilderness and the American Mind*, the historian Roderick Nash tells us that "Americans had not heard the like before." With this idea, Thoreau, "...cut through the channels in which a large portion of thought about wilderness subsequently flowed."

I always thought of Thoreau as a champion of "wild nature" or "wilderness." As many my age did, I had a poster with his quote on my graduate student office wall. However, in *Thoreau's Country*, ecologist David R. Foster reveals that in limiting our notion of Thoreau by simply associating him with this famous quote, we miss the charm, humor, and observational powers of this deep-thinking man. Foster writes: "Given that Thoreau was an inspirational nature writer whose work helped motivate a modern wilderness and preservation movement, it is often presumed that he lived in a largely natural world...This nostalgic vision is quite incorrect...A major theme in Thoreau's landscape was change...Through his musing and reflections on everyday scenes and activities, Thoreau provides us with new insights into the New England

countryside and new ways of recognizing and appreciating the history of natural change."

"Wildness" for Thoreau was a state of mind, rather than a description of place. He could find wildness just about anyplace he looked for it. Thoreau's most famous wild place—Walden Pond—located at the edge of Concord, Massachusetts, was about two miles via the railroad tracks from his mother's kitchen. When he wrote *Walden; or a Life in the Woods*, 60 percent of the New England landscape was in open fields, interspersed with small woodlands and crisscrossed by a dense network of roads. Today, 60 to 90 percent of New England has reverted to forest, and the land has actually become wilder. So, if New England was not all that wild in Thoreau's time, what was the look, the character of the landscape, and how does this impact the New England landscapes we see today?

Thoreau's Country is among several recent books that examine the historical, environmental, and cultural forces that create the landscapes we live in today. An underlying theme in these studies is that our failure to solve environmental problems or resolve conflict between those who would preserve and those who would change, lies, in part, in

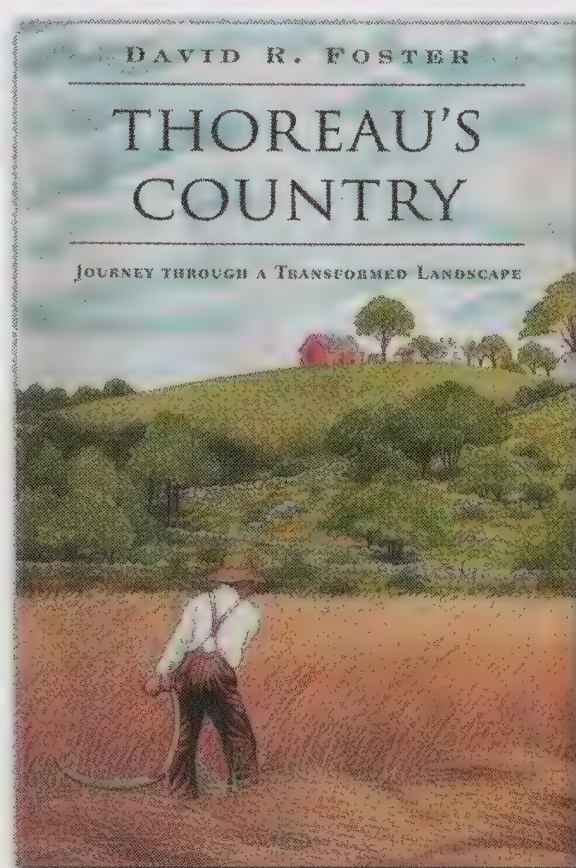
our failure to comprehend the making of modern landscapes. A father can tell his son that a landscape has been transformed, but unless the son experiences it himself, he doesn't really appreciate the extent of change. Specialists call this ecological amnesia, and stress that it strongly affects how we perceive environmental issues as diverse as sustaining populations of endangered butterflies and maintaining grasslands in the eastern United States to judging the sustainability of China's mode of agriculture.

Thoreau was one of the most observant and prolific writers to document the land and natural history and human activity of his time. Over a 40-year period he recorded his observations nearly every day, an effort that resulted in about two million words in 30 volumes, now preserved in New York's Morgan Library. But most of his insightful reflections on natural history were not included in the two books published during his lifetime (1817-1862): *Walden* and *A Week on the Concord and Merrimack Rivers*, although various editions of the journals have been published since his death.

Foster selected passages from the journals that illustrate landscape scenes, natural history processes, and land-use activities that offer "...new and refined insight into the history and ecology of New

England." He also included entries he found amusing. He couples Thoreau's passages with his own introductory essays, which are reader-friendly discussions of current issues in ecology and groups these into sections: "Three Landscapes in New England History," "The Cultural History of New England," "A Natural History of Woodlands," "The Coming of the New Forest," "Losses and Change," and "Stepping Back and Looking Ahead." Foster concludes with a rich "Bibliographic Essay." The essays are accompanied by carefully crafted pen-and-ink drawings based on scenes Thoreau described.

"New England is a cultural landscape, shaped by the interaction of human history and the natural environment. Nearly every acre of the countryside has been directly affected by past land use," Foster writes. Thoreau recorded in great detail many of the processes that would give rise to today's forests and he anticipated and documented the forces behind cultural and ecological changes in New England landscapes. During his years of observation Thoreau came to have a very complete understanding of "The Succession of Forest Trees." He recorded and interpreted the natural processes occurring in the old fields of Concord. He identified the prevalent phenomenon that helped explain the increasing abundance of pine forests in his lifetime and their gradual decline in ours. Foster notes that "...in managing forest areas today, we can use Thoreau's knowledge of succession and landscape history to shape our expectation for



their future and condition, or to modify the approach we take.” Foster believes that if later forest ecologists had read Thoreau’s notes they may have saved themselves decades of research effort.

Thoreau understood how fires shaped forest composition. And, in one delightful passage, we also learn that Thoreau had a talent for spin. “I once set fire to a woods,” Thoreau wrote. The fire started when he and a friend were attempting to cook some trout they had caught. “It burned over a hundred acres or more and destroyed much young wood. When I returned home late in the day, with the others of my townsman (after fighting the fire all day) I could not but help noticing that the crowd who were so ready to condemn the individual who had kindled the fire, did not sympathize with the owners of the wood, but were in fact highly elated as if they were thankful of the opportunity which had afforded them so much sport; and it was only half dozen owners, so called, though not all of them, who looked sour or grieved.”

On a recent trip through New England in search of the “Great North Woods,” my wife and I included *Thoreau’s Country* in our travel library. I had just finished reading and was marveling at the insights and the depth of this thoughtful man as we reached Walden Pond. This was a sort of pilgrimage. We arrived at sunset and found Walden Pond to be a jogging and walking trail—local swimming hole sort of place. It was lovely but there were scores of people using this resource in the context of the culture and economy of our time. Before reading *Thoreau’s Country*, I would have thought that Thoreau would have been shocked by such a loss of “wildness.” I now suspect he would have been mildly amused because he understood and appreciated that we humans are a central environmental force shaping landscapes nearly everywhere.

—John Seidensticker, Curator of Mammals at the National Zoo, is the author of *Tigers* and co-editor of *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes*.



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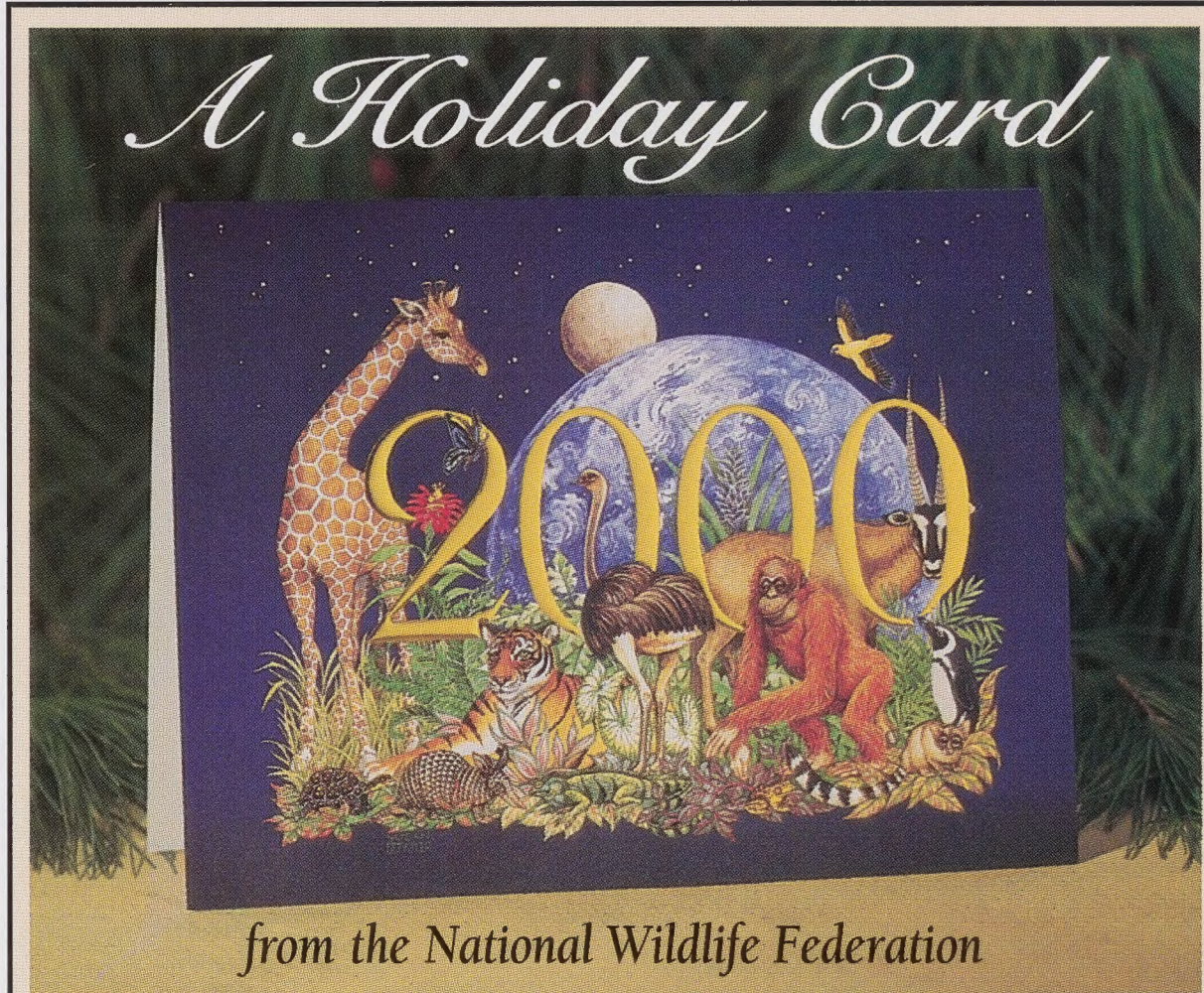
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GOOD NEWS

Crocodiles might not be typical pests, but in recent months they've become a growing nuisance in golf courses and parks in south Florida, confirming that the once critically endangered reptile is now on the rebound in this region. In 1975, biologists estimated that the American crocodile (*Crocodylus porosus*) population had declined to between 200 and 400 individuals restricted to an area within the Everglades National Park and north Key Largo. After being federally listed as an endangered species in 1975, the number of crocs has nearly doubled, and researchers excitedly report finding nests in Biscayne Bay for the first time in a century. Conservationists attribute the crocodiles' comeback to the protection granted under the Endangered Species Act, to the regrowth of mangrove habitat, and to the restoration of fresh water flow in South Florida estuaries. The cooling canals at the Turkey Point nuclear plant south of Miami have also unexpectedly provided ideal crocodile nesting sites.

South Florida is the only place in the United States where the American crocodile lives, and the only place in the world where crocs and alligators both occur. Unlike its notorious African and Australian cousins, the American



crocodile avoids confrontations with people. Still, the reptiles should be treated with respect. Feeding crocs is a particularly bad idea: When the animals associate people with food, they sometimes can't tell where the handout ends and the hand begins.

—from Environmental News Network (ENN.com), June 15, 1999

BAD NEWS

Without dramatic intervention, the chinook salmon (*Oncorhynchus tshawytscha*) in the Snake River may become extinct within the next 20 years. A recent study found that decreasing numbers of salmon are returning each year to spawn in Snake River tributaries. If present trends continue, the study predicts, these salmon will be categorized as functionally extinct sometime between the years 2008 and 2017. While some fish may return to spawn in 2017, the population size will have dwindled to such a point that inbreeding will rapidly corrupt the species' genetic diversity. Since the late 1800s, when approximately 1.5 million chinook returned to their Snake River breeding grounds annually, a variety of human factors, including the construction of dams, overfishing, and habitat destruction, have contributed to the salmon's decline. The good news is that under the right conditions, these fish have a tremendous re-



productive capability, which suggests that immediate action may save the chinook for future generations.

—from Environmental News Network (ENN.com), July 12, 1999

AREA SCENE

While we eagerly await the culinary delights of the holiday season, our neighborhood mammals are busily upping their caloric intake in anticipation of winter. The North American raccoon (*Procyon lotor*), the notorious backyard garbage bandit, has turned weight gaining into an art. Through the course of the summer and early fall, raccoons accumulate a thick layer of fat over their entire bodies, including their ringed tails. At higher latitudes, where raccoons are challenged by severe winter weather, some individuals may gain four to seven pounds in the fall, with a fat layer accounting for 50 percent of their body mass. Raccoons are not true hibernators, but as the temperature drops below freezing, they greatly reduce their activity, foraging on warmer evenings, but mostly relying on the stored energy in their fat reserves to carry them through the winter.

WHAT'S IN A NAME?

If you were to take one representative of every species of plant and animal on Earth and arrange

them in a line, every fifth organism would be a beetle. The staggering diversity of Coleoptera, the order that encompasses beetles, presents entomologists with a potentially onerous task: naming the unending flow of newly discovered species. How do beetle specialists respond to this challenge? Playfully. Terry Erwin at the National Museum of Natural History studies tree-dwelling beetles in the genus *Agra* that live in the forest canopy of South America. One shiny black species is only found in the dwindling habitat of the tropical lowlands of southwestern Brazil. Due to extensive forest destruction in this area, Erwin named the species *A. calamitas*, borrowing the Latin root calamit, meaning misfortune or disaster. A beautiful metallic green Peruvian species with red and black coloration was named *Agra vation*. A meddlesome beetle with squirting poison glands? No,

Erwin says, there's nothing aggravating about *A. vation*. Other beetles have been graced with names such as

Agra cadabra, *A. phobia*, and *A. eponine*

(after the street urchin in *Les Misérables*).

For more examples of serious scientists concocting tongue-in-cheek nomenclature, visit:

www.best.com/~atta/taxonomy.html.

—Tim Stoddard



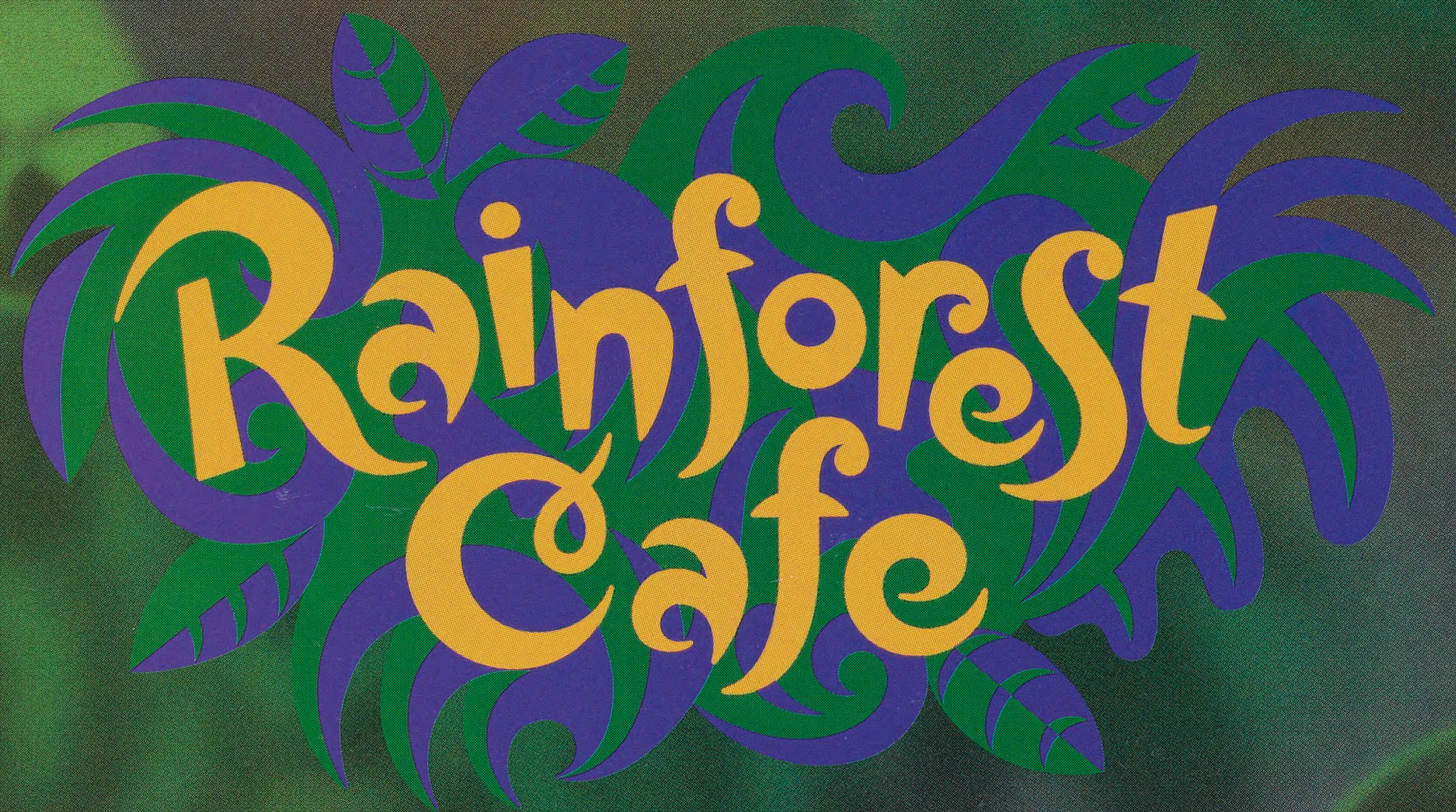


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